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## Digital Mapping, Charting, and Geodesy Analysis Program (DMAP)

# Technical Review of Proposed Ice Objects for AML

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# Digital Mapping, Charting, and Geodesy Analysis Program (DMAP) Technical Review of Proposed Ice Objects for AML

## 1.0 Background

The United Kingdom Hydrographic Office requested a review of proposals received for incorporating ice objects in to the Additional Military Layers (AML) product. Two proposals were made by the Canadian Ice Service: 1) No amendments are necessary to ice objects in Maritime Foundation and Facilities (MFF) product specification and 2) High Resolution Environment (HRE) (or Environment, Seabed and Beach (ESB)) is revised to bring it into line with the ECDIS Ice Objects Version 3.0, but without extending the scope of HRE. It is noted that MFF and HRE (or ESB) both contain Sea Ice – Ice Area and Land Ice – Ice Area. Separate consideration will be given to removing all ice from MFF to ensure that there is no duplication of data (or to confirming that there are different specifications for different purposes).<sup>1</sup>

For this review, DMAP specifically focused on Annex A<sup>2</sup> of the referenced document which presented the proposed changes to the AML Product Specification HRE to bring it into line with the ECDIS Ice Objects. The following areas are discussed within this review:

- problems of temporal stability
- lack of codes for icebergs
- World Meteorological Organization Ice Chart Symbolology “Egg Code”
- AML ice features as compared to DIGEST, SEDRIS, and IHO S-57.

A review of the DIGEST FACC indicated insufficient features and attributes to encode sea ice information. It is the opinion of DMAP that neither the AML objects nor Digital Geographic Information Exchange Standard (DIGEST) are sufficient to handle the required information. We recommend that at a minimum, the features and attributes should permit the encoding of the essential information contained in the World Meteorological Organization (WMO) “Egg Code” (see <http://www.natice.noaa.gov/sigrid.htm> and <http://www.natice.noaa.gov/egg.htm> for complete specifications). This is discussed in detail in Section 3.

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<sup>1</sup> United Kingdom Hydrographic Office, HA324/006/030/01, dtd 20 June 2001, *Update Following Ad Hoc Hydrographic Working group 24-25 April 2001. AML Product Specifications.*

<sup>2</sup> Ibid.

Manuscript approved August 10, 2001.

## 2.0 Noted Omissions

The inclusion of sea ice and iceberg information with navigation chart information is beneficial, but not without the problem of how to handle perishable data, i.e., information that is valid only for a short time span.

## 2.1 Temporal Stability

Charts historically have displayed information that was, in general, temporally stable within the frequency of the chart update/publish cycle. Sea ice is highly variable in both its spatial and temporal aspects. The addition of sea ice to charts/navigation display can be highly effective, but the information must be current and accurate. Looking at "outdated" ice information could lead to problems when operating in ice prone regions. In many situations, no information is better than false (or outdated) information. With "no ice" information, but ice a possibility, appropriate watch and operational procedures would be implemented. However, with "ice" indicated on the navigational display, a course would be steered to avoid the ice and no extra precautions taken. But the ice could have moved and the displayed information is no longer current, causing the vessel to operate in a less than prudent manner.

With this in mind it is essential that ice or temporally variable information be handled and attributed appropriately, possibly with the attributes for time of 1) issue, 2) forecast validity, and 3) expiration. It is recommended that discussion be conducted and consideration be given to developing standards and procedures for perishable data when used in conjunction with electronic chart displays.

## 2.2 Icebergs

DIGEST does not contain feature or attribute codes that specify icebergs. Consideration of attributes and values might prove useful. The following list is offered<sup>3</sup>:

*BJ Hydrography – Snow/Ice*  
*BJ050 Iceberg*

And when needed as a value rather than a feature:

*Ice Classification*  
ICC 10 Iceberg

Potential attributes that might be associated with *BJ050 Iceberg* are:

NAM Name of iceberg  
LEN Length (approximate m)

<sup>3</sup> Italics denote possible values for inclusion in DIGEST.

|     |   |
|-----|---|
| WID | Width (approximate m)                                   |
| DTE | Expiration date of information                          |
| ELA | Elevation accuracy                                      |
| EXS | Existence category                                      |
| HGT | Height above surface (approximate m)                    |
| HDP | Depth below surface (approximate m)                     |
| HYC | Hydrological category                                   |
| LOC | Location category                                       |
| xxx | <i>Date/time last position fix</i>                      |
| xxx | <i>Estimate direction of movement (ref. true north)</i> |
| xxx | <i>Estimate speed of movement (knots)</i>               |

### 3.0 World Meteorological Organization

#### 3.1 Ice Chart Symbology – Egg Code

As mentioned previously, it is suggested that the information content of the “egg code” would be a good starting point for the identification of sea ice attributes. Toward this end we have included an explanation of the “egg code” as given by NOAA. Further information can be obtained through their website: <http://www.natice.noaa.gov>.

The World Meteorology Organization (WMO) system for sea ice symbology is more frequently referred to as the “Egg Code” due to the oval shape of the symbol.<sup>4</sup> As shown in Fig. 1, the Egg is made up of four identifiers: Total Concentration, Partial Concentrations, Stage of Development, and Floe Size.

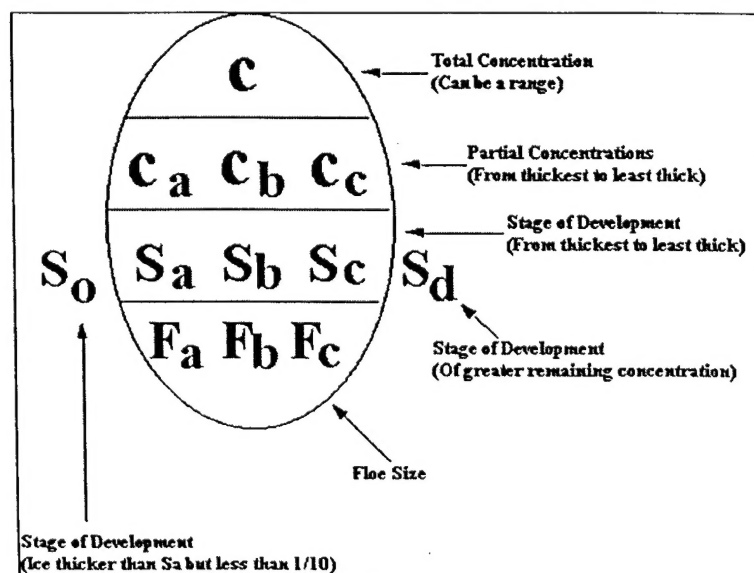


Fig. 1. World Meteorological Organization “Egg Code” for Sea Ice Symbology

<sup>4</sup> World Meteorological Organization website, <http://www.natice.noaa.gov/egg.htm>

The following is an example of “egg codes” in use from [http://www.natice.noaa.gov/pub/special\\_report/forecast/East/2001/w30daye010401gif](http://www.natice.noaa.gov/pub/special_report/forecast/East/2001/w30daye010401gif).

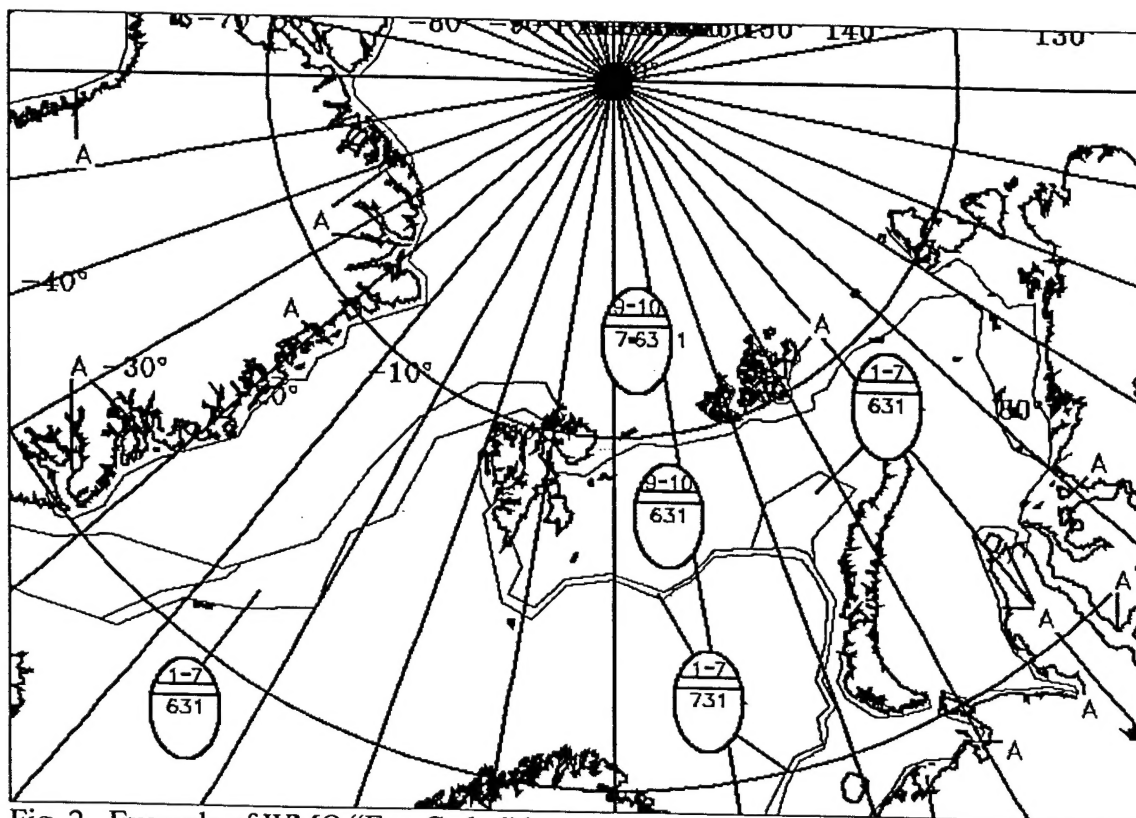


Fig. 2. Example of WMO “Egg Codes” in use.

Each of these identifiers is then defined further by specific codes to identify concentration and stages of development. The following tables give examples of the associated definitions and attributes for Concentration, Stages of Development and Forms of Sea Ice.

The detail of the code values can become confusing if not familiar, as can be seen from the following tables. To start with an explanation, C represents concentration, S equals Stage of Development, and F is Forms of Ice. The a, b, c are first, second and third values; p is predominant, s is secondary. However, rather than paying attention to the schema to arrive at the value headings, concentrate on the definitions as these would represent values for attribute features in DIGEST (see Section 4 for examples of possible DIGEST feature and attribute codes).

**Table 1. Sea Ice Concentration Symbols**

| <b>Sea Ice Concentration Symbols</b> |  | <b>Variable(s)</b> |
|--------------------------------------|--|--------------------|
| <b>CT</b>                            | Total concentration, CC (Code Table 1)   | CC                 |
| <b>CA</b>                            | Partial concentration, stage of development and form of thickest ice CaCaSaSaFaFa (Code tables 1, 2, and 3)  | CaCaSaSaFaFa       |
| <b>CB</b>                            | Partial concentration, stage of development and form of second thickest ice CbCbSbSbFbFb (Code tables 1, 2, and 3)   | CbCbSbSbFbFb       |
| <b>CC</b>                            | Partial concentration, stage of development and form of third thickest ice CcCcScScFcFc (Code tables 1, 2, and 3)  | CcCcScScFcFc       |
| <b>CF</b>                            | Predominant FpFp and secondary FsFs form of ice (Code table 3)   | FpFpFsFs           |
| <b>CN</b>                            | Stage of development of ice thicker than reported by SaSa but with a concentration less than 1/10, SoSo (Code table 2)   | SoSo               |
| <b>CD</b>                            | Stage of development of any remaining class of ice not reported under CA, CB, or CC (Code table 2). Note that no concentration or form of ice is reported for SoSo and SdSd. | SdSd               |

**Table 2. Sea Ice Variables**

| <b>List of Sea Ice Variables</b> |  |
|----------------------------------|--|
| <b>Variable Code</b>             | <b>Definition</b>  |
| <b>CC</b>                        | Total concentration of all ice in the area, reported in tenths (Code Table 1)  |
| <b>CaCaCbCbCcCc</b>              | Partial concentration of respectively thickest, second thickest and third thickest ice reported in tenths (Code Table 1)   |
| <b>FaFaFbFbFcFc</b>              | Form of ice corresponding to SASa, SbSb, and ScSc respectively (Code Table 3)  |
| <b>FpFpFsFs</b>                  | Predominant (FpFp) and Secondary (FsFs) form of ice (Code Table 3)   |
| <b>SaSaSbSbScSc</b>              | Stage of development of respectively thickest, second thickest and third thickest ice of which the concentration is reported CaCa, CbCb and CcCc respectively (Code Table 2) |
| <b>SdSd</b>                      | Stage of development of any remaining class of ice not reported by SaSa, SbSb, ScSc or SoSo (Code Table 2)   |
| <b>SoSo</b>                      | Stage of development of ice thicker than SaSa but with a concentration less than 1/10 (Code Table 2)   |

Table 3 shows the code figure values used within the "egg code" and the definitions for each of the Code Tables for Concentration, Stage of Development and Form of Ice.



### 3.2 Comparison of WMO "Egg Code" and AML Sea Ice

An attempt was made to map the WMO "egg code" into the defined AML features and attributes for Sea Ice and it was found that there were only a few in agreement. We recommend that this be pursued.

### 4.0 Comparison Review of AML Sea Ice with DIGEST, SEDRIS, and IHO S-57 Standards

#### Possible DIGEST and FACC Codes for Sea Ice

A review of the tables in Appendices A-D indicate that there is no clear cut comparison for the AML Sea Ice requirements within existing DIGEST, Synthetic Environment Data Representation & Interchange Specification (SEDRIS), or IHO S-57 (Digital Hydrographic Data) codes. It should be noted from these tables that some codes are included, most are not. For this reason, a conversion to the DIGEST Feature and Attribute Code Catalog (FACC) would require a new FACC code for Sea Ice (e.g., *BJ010*<sup>5</sup>), with the following possible structure. Note, an attribute for Sea Ice already exists in DIGEST (i.e., ICC, value 2); however the FACC structure does not allow for additional values specifically related to sea ice. It is therefore recommended that a new FACC code for Sea Ice be developed within DIGEST, using the values and attributes of the "egg code", with the following as a possible structure:

#### **BJ Hydrography – Snow/Ice** ***BJ010 Sea Ice***

| <b>Attribute</b>   | <b>Definition</b>  |
|--------------------|--|
| <b><i>CCN</i></b>  | <b><i>Concentration</i></b><br><i>(identified and defined in Table 3, Code Table 1)</i>                            |
| <b><i>ICD</i></b>  | <b><i>Stage of Development or Thickness of Ice</i></b><br><i>(identified and defined in Table 3, Code Table 2)</i> |
| <b><i>ICC*</i></b> | <b><i>Form of Ice</i></b><br><i>(identified and defined in Table 3, Code Table 3)</i>                              |

\* ICC already exists as a feature in FACC, the attribute *Form of Ice* does not.

Appendix E is a combined comparison chart for all four documents referencing sea ice.

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<sup>5</sup> Proposed additions to DIGEST.

## **5.0 Conclusions and Recommendations**

Neither DIGEST nor the proposed AML features adequately describe ice features when the WMO Egg Code is used as a starting point for the identification of the salient attributes.

Additionally, the combination of "perishable" data with electronic chart display, could result in less than prudent ship navigation if not handled appropriately.

With this in mind, the following recommendations are made:

- Develop standardized methods for the handling and display of perishable data in conjunction with electronic chart display.
- Expand DIGEST Features and Attributes to adequately contain sea ice and iceberg information as specifically mentioned in Section 2.
- Expand the proposed AML codes to accommodate ice features adequately and to deal with the "perishable" data problem.
- Expand the proposed AML codes to reflect World Meteorological Organization "Egg Code" features and attributes.
- Ensure the National/Naval Ice Center has reviewed content requirements with their domain knowledge and naval mission in mind.

## **6.0 Acknowledgments**

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**Table 3. Value and Definitions of Concentration, Stage of Development, and Form of Ice**

| Code Figure | Code Table 1 – Concentration (CC, Ca, Ch, Cc) |                             | Code Table 2 – Thickness of Ice or Stage of Development (Sa, Sd, So) |           | Code Table 3 – Form of Ice (Fa, Fp) |                      |
|-------------|---|-----------------------------|--|-----------|-------------------------------------|----------------------|
|             | Value   | Definition                  | Stage of Development   | Thickness | Form                                | Size Concentration   |
| 00          |   | Ice Free                    | Ice Free   |           | Pancake Ice                         | 30 cm – 3 m          |
| 01          |   | Less than 1/10 (open water) |  |           | Shuga/Small Ice Cake, Brash Ice     | < 2 m across         |
| 02          |   | Bergy Water                 |  |           | Ice Cake                            | < 20 m across        |
| 03          |   |                             |  |           | Small Floe                          | 20 m – 100 m across  |
| 04          |   |                             |  |           | Medium Floe                         | 100 m – 500 m across |
| 05          |   |                             |  |           | Big Floe                            | 500 m – 2 km across  |
| 06          |   |                             |  |           | Vast Floe                           | 2 km – 10 km across  |
| 07          |   |                             |  |           | Giant Floe                          | > 10 km across       |
| 08          |   |                             |  |           | Fast Ice                            |                      |
| 09          |   |                             |  |           | Growlers, Floebergs or Floebits     |                      |
| 10          | 1/10  |                             |  |           | Icebergs                            |                      |
| 11          |   |                             |  |           | Strips and Patches                  | Concentration: 1/10  |
| 12          |   |                             |  |           | Strips and Patches                  | Concentration: 2/10  |
| 13          |   |                             |  |           | Strips and Patches                  | Concentration: 3/10  |
| 14          |   |                             |  |           | Strips and Patches                  | Concentration: 4/10  |
| 15          |   |                             |  |           | Strips and Patches                  | Concentration: 5/10  |
| 16          |   |                             |  |           | Strips and Patches                  | Concentration: 6/10  |
| 17          |   |                             |  |           | Strips and Patches                  | Concentration: 7/10  |
| 18          |   |                             |  |           | Strips and Patches                  | Concentration: 8/10  |
| 19          |   |                             |  |           | Strips and Patches                  | Concentration: 9/10  |
| 20          | 2/10  |                             |  |           | Strips and Patches                  | Concentration: 10/10 |
| 21          |   |                             |  |           | Level Ice                           |                      |
| 30          | 3/10  |                             |  |           |                                     |                      |
| 40          | 4/10  |                             |  |           |                                     |                      |
| 50          | 5/10  |                             |  |           |                                     |                      |
| 60          | 6/10  |                             |  |           |                                     |                      |
| 70          | 7/10  |                             |  |           |                                     |                      |
| 80          | 8/10  |                             | No Stage of Development  |           |                                     |                      |
| 81          |   |                             | New Ice  |           |                                     |                      |
| 82          |   |                             | Nilas, Ice Rind  | < 10 cm   |                                     |                      |

| Code Figure | Code Table 1 –<br>Concentration<br>(CC, Ca, Ch, Cc)<br>Definition | Code Table 2 –<br>Thickness of Ice or Stage of<br>Development (Sa, Sd, So) |             | Code Table 3 –<br>Form of Ice (Fa, Fp) |                    |
|-------------|---|--|-------------|--|--------------------|
|             |   | Stage of Development   | Thickness   | Form                                   | Size Concentration |
| Value       |   | Young Ice  | 10 – 30 cm  |  |                    |
| 83          |   | Grey Ice   | 10 – 15 cm  |  |                    |
| 84          |   | Grey – White Ice   | 15 – 30 cm  |  |                    |
| 85          |   | First Year Ice   | 30 – 200 cm |  |                    |
| 86          |   | Thin First Year Ice  | 30 – 70 cm  |  |                    |
| 87          |   | Thin First Year Stage 1  | 30 – 50 cm  |  |                    |
| 88          |   | Thin First Year Stage 2  | 50 – 70 cm  |  |                    |
| 89          |   | For Later Use  |             |  |                    |
| 90          | 9/10  | Medium First Year Ice  | 70 – 120 cm |  |                    |
| 91          | More than 9/10 less than 10/10                                    | For Later Use  |             |  |                    |
| 92          | 10/10   | Thick First Year Ice   | > 120 cm    |  |                    |
| 93          |   | For Later Use  |             |  |                    |
| 94          |   | Old Ice  |             |  |                    |
| 95          |   | Second Year Ice  |             |  |                    |
| 96          |   | Multi-Year Ice   |             |  |                    |
| 97          |   | Glacier Ice  |             |  |                    |
| 98          |   | Undetermined/Unknown   |             | Undetermined/Unknown                   |                    |
| 99          |   |  |             |  |                    |



**Appendix A**  
**DIGEST FACC, Part 4, Annex A – Feature Codes<sup>6</sup>**

**BB – Hydrography – Ports and Harbors**

**BB202 Ice Boom**

Floating barriers, anchored to the bottom, used to deflect the path of floating ice in order to prevent the obstruction of locks, intakes, etc., and to prevent damage to bridge piers and other structures.

**BD - Hydrography-Dangers/Hazards**

**BD000 US-Underwater Danger/Hazard UK-Underwater Danger**

A known underwater object or area, known to be dangerous to surface navigation.

**BD005 Miscellaneous Underwater Feature**

An object or area on the sea floor or underwater that is not identified by any other code in this specification. (Also see BD000)

**BD070 Obstruction (Nautical)**

A danger to navigation, the exact nature of which is not specified, or has not been determined.

**BJ - Hydrography-Snow/Ice**

**BJ020 Moraine**

An accumulation of soil and stone debris deposited by a glacier.

**BJ030 Glacier**

A large mass of snow and ice moving slowly down a slope or valley from above the snowline.

**BJ040 Ice Cliff**

The vertical face of a glacier or ice shelf.

**BJ060 Ice Peak/Nunatak**

A rocky peak projecting above a surrounding ice field that may be perpetually covered with ice.

**BJ065 Ice Shelf**

A sheet of thick ice, with level or undulating surface, attached to the land but mostly afloat which is bounded on the seaward side by an Ice Cliff (BJ040).

**BJ070 Pack Ice**

An area of ice formed by the drifting and crushing together of floating pieces of ice.

**BJ080 Polar Ice**

The heaviest, thickest form of ice over land or water (see also BJ100)

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<sup>6</sup> Digital Geographic Information Working Group, *The Digital Geographic Information Exchange Standard (DIGEST), Part 4 – Annex A, Feature Codes*, Ed. 2.1, September 2000.

**BJ100 Snow Field/Ice Field**

A large area permanently covered by snow or ice over land or water (see also BJ080)

**BJ110 Tundra**

A prairie-like region in the Arctic and Subarctic zones which sustains a growth of low vegetation.

**Appendix B**  
**DIGEST FACC, Part 4, Annex B – Attribute and Value Codes<sup>7</sup>**

**ICC Ice Classification**

Tabulates the kind of ice.

|     |     |                       |
|-----|-----|-----------------------|
| ICC | 0   | Undefined             |
| ICC | 1   | Fast ice              |
| ICC | 2   | Sea ice               |
| ICC | 3   | Growler area          |
| ICC | 4   | Pancake ice           |
| ICC | 5   | Glacier (See BJ030)   |
| ICC | 6   | Ice Peak (See BJ060)  |
| ICC | 7   | Pack ice (See BJ070)  |
| ICC | 8   | Polar ice (See BJ080) |
| ICC | 9   | Debris-covered        |
| ICC | 997 | Unpopulated           |
| ICC | 998 | Not Applicable        |
| ICC | 999 | Other                 |

**ICE Ice Factor**

The value of the maximum variation in the vertical clearance of an overhead cable due to an accumulation of ice.

|     |   |              |
|-----|---|--------------|
| ICE | 0 | Actual Value |
|-----|---|--------------|

**MCC Material Composition Category**

Characteristics of primary material composition of feature.

|     |     |          |
|-----|-----|----------|
| MCC | 103 | Snow/Ice |
|-----|-----|----------|

**SIC Snow/Ice Category**

Indicates the composition of the feature.

|     |     |                |
|-----|-----|----------------|
| SIC | 0   | Unknown        |
| SIC | 1   | Snow           |
| SIC | 2   | Ice            |
| SIC | 997 | Unpopulated    |
| SIC | 998 | Not Applicable |
| SIC | 999 | Other          |

**UMC Underlying Material Characteristics**

Characteristics of underlying material composition of feature.

|     |    |         |
|-----|----|---------|
| UMC | 19 | Glacial |
|-----|----|---------|

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<sup>7</sup> Digital Geographic Information Working Group, *The Digital Geographic Information Exchange Standard (DIGEST), Part 4 – Annex B, Attribute and Value Codes*, Ed. 2.1, September 2000.



**Appendix C**  
**IHO S-57 Appendix A<sup>8</sup>**

**Category of Ice**

Feature Code: CATICE

| ID | Meaning      | Definition   |
|----|--------------|--|
| 1  | Fast ice     | Sea ice which remains fast, generally in the position where originally formed, and which may attain a considerable thickness. It is found along coasts, where it is attached to the shore, or over shoals, where it may be held in position by islands, grounded icebergs or grounded polar ice. |
| 2  | Sea ice      | Any form of ice which has originated from sea water. Generally any ice in the sea.   |
| 3  | Growler area | A low-lying mass of flow ice which is not easily seen by approaching vessels owing to its dark indigo colour. It is therefore a menace to shipping. It is usually caused by the capsizing and disintegration of an iceberg.  |
| 4  | Pancake ice  | Pieces of new ice, usually approximately circular, about 30 cm to 3 m across, and with raised rims, due to the pieces striking against each other as the result of wind and swell.   |
| 5  | Glacier      | A mass of snow and ice continuously moving from higher to lower ground or, if afloat, continuously spreading.  |
| 6  | Ice peak     | [no definition provided]   |
| 7  | Pack ice     | Term used in a wide sense to include any area of sea ice, other than fast ice, no matter what form it takes or how it is disposed.   |
| 8  | Polar ice    | Sea ice that is more than one year old (in contrast to winter ice). The WMO code defines polar ice as any sea ice more than one year old and more than 3 metres thick.   |

Remark: Ice is the topic of another group and is subject to a future extension to this document.

<sup>8</sup> International Hydrographic Organization, *IHO Transfer Standard for Digital Hydrographic Data, Ed. 3.0, Special Publication No. 57*, November 1996.

## Appendix D SEDRIS

### Hydrography – Dangers/Hazards

|       |                                  |  |
|-------|----------------------------------|--|
|       |                                  |  |
| BD000 | Underwater Danger                | A known underwater object or area, known to be dangerous to surface navigation.  |
| BD005 | Miscellaneous Underwater Feature | An object or area on the sea floor or underwater that is not identified by any other code in this specification (see also BD000) |
| BD070 | Obstruction (Nautical)           | A danger to navigation, the exact nature of which is not specified, or has not been determined.                                  |

### Hydrography – Snow/ice

|       |                        |   |
|-------|------------------------|---|
|       |                        |   |
| BJ020 | Moraine                | An accumulation of soil and stone debris deposited by a glacier.  |
| BJ030 | Glacier                | A large mass of snow and ice moving slowly down a slope or valley from above the snowline.  |
| BJ040 | Ice Cliff              | The vertical face of a glacier or ice shelf.  |
| BJ060 | Ice Peak/Nunatak       | A rocky peak projecting above a surrounding ice field that may be perpetually covered with ice.   |
| BJ065 | Ice Shelf              | A sheet of thick ice, with level or undulating surface, attached to the land but mostly afloat which is bounded on the seaward side by an ice cliff (BJ040) |
| BJ066 | Ice Keel               | An irregular linear downward extension of sea ice formed where two moving areas of ice.   |
| BJ070 | Pack Ice               | An area of ice formed by the drifting and crushing together of floating pieces of ice.  |
| BJ075 | Polynya                | A large area of open water surrounded by sea ice.   |
| BJ080 | Polar Ice              | The heaviest, thickest form of ice over land or water (see also BJ100).   |
| BJ100 | Snow Field / Ice Field | A large area permanently covered by snow or ice over land or water (see also BJ080).  |
| BJ110 | Tundra                 | A prairie-like region in the Arctic and Subarctic zones which sustains a growth of low vegetation.  |

**Appendix E**  
**Comparison Chart of AML Ice Objects, DIGEST Attributes and Values,**  
**SEDRIS and IHO S-57**

| <b>ECDIS Ice Object</b>   | <b>HRE Comments</b>   | <b>AML Object</b> | <b>DIGEST FACC Code (and SEDRIS)</b>            | <b>DIGEST Attribute &amp; Value</b> | <b>IHO S-57 CATICE</b> |
|---------------------------|---|-------------------|---|-------------------------------------|------------------------|
| <b>Sea Ice</b>            | Model as ECDIS Ice Objects but with lower level of attribution.                               | Sea Ice           |   | ICC 2 Sea Ice                       | Sea Ice                |
| <b>Lake Ice</b>           | Suggest that this is not required for AML   | --                |   |                                     |                        |
| <b>Ice Advisory Area</b>  | May be worth including in Routes, Areas and Limits  | --                |   |                                     |                        |
| <b>Iceberg Area</b>       | Model as ECDIS Ice Objects  | Iceberg           |   |                                     |                        |
| <b>Land Ice</b>           | Model as ECDIS Ice Objects  | Glacier           | BJ030 Glacier                                   | ICC 5 Glacier<br>UMC 19 Glacial     | ICEARE<br>Glacier      |
| <b>Ice Line</b>           | Not required for AML  | --                |   |                                     |                        |
| <b>Ice Route</b>          | Not required for AML  | --                |   |                                     |                        |
| <b>Ice Fracture</b>       | Could include but would require further definitions   | --                |   |                                     |                        |
| <b>Ice Polynya</b>        | Model as ECDIS Ice Objects  | Polynia           | BJ075 Polynya<br>(SEDRIS only)                  |                                     |                        |
| <b>Ice Lead</b>           | Model as ECDIS Ice Objects  | Lead              |   |                                     |                        |
| <b>Iceberg</b>            | Include   | Iceberg           |   |                                     |                        |
| <b>Floeberg</b>           | Not necessary for AML to differentiate between an iceberg and a floeberg                      | --                |   |                                     |                        |
| <b>Ice/Snow Thickness</b> | Not necessary for AML, thickness attributes on sea ice object sufficient                      | --                |   |                                     |                        |
| <b>Ice Movement</b>       | Not required for AML  | --                |   |                                     |                        |
| <b>Ice Dynamics</b>       | Not required for HRE or Maritime Foundation and Facilities                                    | --                |   |                                     |                        |
| <b>Ice Ridge</b>          | Not required for AML  | --                |   |                                     |                        |
| <b>Ice Opening</b>        | Could use object Ice Opening instead of ice lead, ice polynya and ice fracture or not include | Lead              |   |                                     |                        |
| <b>Ice Topography</b>     | ICETOP. Not required for AML  |                   |   |                                     |                        |
|                           |   |                   |   | ICE 0 Ice Factor                    |                        |
|                           |   |                   |   | MCC 103 Snow/Ice                    |                        |
|                           |   |                   |   | SIC 1 Snow                          |                        |
|                           |   |                   |   | SIC 2 Ice                           |                        |
|                           |   |                   |   |                                     |                        |
|                           |   |                   | BB202 Ice Boom                                  |                                     | Ice Boom               |
|                           |   |                   | BD000 Underwater<br>Danger/Hazard               |                                     | OBSTRN                 |
|                           |   |                   | BD005<br>Miscellaneous<br>Underwater<br>Feature |                                     |                        |

| <b>ECDIS Ice Object</b> | <b>HRE Comments</b> | <b>AML Object</b> | <b>DIGEST FACC Code (and SEDRIS)</b> | <b>DIGEST Attribute &amp; Value</b> | <b>IHO S-57 CATICE</b>        |
|-------------------------|---------------------|-------------------|--------------------------------------|-------------------------------------|-------------------------------|
|                         |                     |                   | BD070 Obstruction                    |                                     |                               |
|                         |                     |                   | BJ020 Moraine                        |                                     |                               |
|                         |                     |                   | BJ040 Ice Cliff                      |                                     |                               |
|                         |                     |                   | BJ060 Ice Peak/<br>Nunatak           | ICC 6 Ice Peak                      | HILTOP Ice Peak               |
|                         |                     |                   | BJ065 Ice Shelf                      |                                     | ICEARE Ice Shelf              |
|                         |                     |                   | BJ066 Ice Keel<br>(SEDRIS only)      |                                     |                               |
|                         |                     |                   | BJ070 Pack Ice                       | ICC 7 Pack Ice                      | Pack Ice                      |
|                         |                     |                   | BJ080 Polar Ice                      | ICC 8 Polar Ice                     | Polar Ice                     |
|                         |                     |                   | BJ100 Snow Field/<br>Ice Field       |                                     | ICEARE Snowfield<br>/Icefield |
|                         |                     |                   | BJ110 Tundra                         |                                     |                               |
|                         |                     |                   |                                      | ICC 1 Fast Ice                      | Fast Ice                      |
|                         |                     |                   |                                      | ICC 3 Growler Area                  | Growler Area                  |
|                         |                     |                   |                                      | ICC 4 Pancake Ice                   | Pancake Ice                   |